NEMO Retroreflector Array

G. Charmaine Gilbreath, Code 7210 and Robert Kessel, Code 8123
Naval Research Laboratory
4555 Overlook Ave., SW
Washington, D. C. 20375
phone: (202) 404-6170 fax: (202) 767-6611 e-mail: kessel@ncst.nrl.navy.mil
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LONG-TERM GOAL

A compact 22-element 1 cm retroreflector array will be carried aboard the joint ONR commercial hyperspectral remote sensing Naval EarthMap Observer (NEMO) satellite as an experimental package. Figure 1 illustrates the concept. The primary interest within the NEMO program is the comparison between the spacecraft's on-board GPS derived orbit and an independent Satellite Laser Ranging (SLR) orbit. The presence of the retroreflector array aboard NEMO also affords additional research opportunities into orbital dynamics and atmospheric correction of hyperspectral data. NEMO's current launch date is June 2000.

OBJECTIVES

NEMO has a demanding geolocation requirement which will be met by combining onboard GPS receivers with subsequent ground processing of differential GPS corrections. The high precision inherent in SLR-based orbits is sufficient to provide an independent calibration of NEMO’s GPS-based orbits. Should the NEMO GPS system degrade or fail during flight, SLR can serve as a backup. Inclusion of the retroreflector array allows for other objectives. NEMO will be in a relatively low 605 km 10:30 am sun-synchronous orbit. Given the low orbit combined with relative large solar arrays, NEMO provides an opportunity to refine atmospheric drag models for this altitude. The closed optical link required for SLR and the high sensitivity of NEMO's primary sensors at SLR wavelengths could make two further coupled objectives possible. An independent determination of the atmospheric transmission between the ground and NEMO can be based on the SLR return flux intensity. A hyperspectral observation of the SLR ground station during active ranging will provide data for the validation of the atmospheric correction algorithms. The same type of observation would allow for the active calibration of the primary sensors.

APPROACH

The approach is to leverage an already existing retroarray design which was optimized by NRL for another LEO program. This array can provide robust link closure (i.e.: enough return photons to obtain a signal) for a LEO spacecraft orbiting at 1000 km in altitude or lower using the most modest of the NASA SLR ground-based systems (Transportable Laser Ranging Systems). This array was designed, built, and space qualified by NRL. Laser Radar Cross Section was experimentally measured to confirm analytical predictions as described in Reference 2. Consequently, a duplicate of the array can be obtained and space qualified “by simulation” for a substantial reduction is costs.

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WORK COMPLETED

The fused silica centimeter retroreflectors have been ordered and are due for delivery in late spring, 1999. Contracts for the mount and related hardware have been made and deliverables are expected in the same timeframe. An integrated array is expected to be completed in early summer. Nominal vibration and temperature tests will be performed. It is anticipated that the array will be ready for spacecraft integration in late fourth quarter, FY99.

RESULTS

Acquisition is on schedule.

IMPACT/APPLICATION

The NEMO retroreflector array applies recent developments in SLR to both gain operational flexibility and expand research opportunities. Gaining operational flexibility supports the same Science and Technology Guidance (STRG) requirements addressed by the broader NEMO program. These requirements are primarily concerned with improving knowledge of the Littoral environment. Refinements of the atmospheric correction algorithms for hyperspectral data can improve sensor efficiency (STRG 98 2.1.a; Tier: H) and improve signature characterization (STRG 98 2.2.c; Tier: H). Active calibration of the NEMO primary sensors might be adapted to sensors at other wavelengths (STRG 98 12.2.d; Tier: H).

TRANSITIONS

Given that the NEMO retroreflector array has primarily operational and system validation objectives, transition opportunities in this area do not a strong emphasis. Some exist such as using the SLR/GPS cross comparison on operational spacecraft. However, the data collected can provide research opportunities in atmospheric correction algorithms which have direct relevance to free space optical data transfer.

RELATED PROJECTS

NEMO

REFERENCES

1. Degnan, John J., "Millimeter Accuracy Satellite Laser Ranging A Review", *Contributions of Space Geodesy to Geodynamics Technology*, **25**, 133--162, 1993.
2. Gilbreath, G. Charmaine, Peter B. Rolsma, Robert Kessel, Robert B. Patterson and James A. Georges III, "Performance Characteristics of a Retroreflector Array Optimized for LEO Spacecraft", NRL Report NRL/FR/8120--97-9875, Naval Research Laboratory, December 31, 1997.

PUBLICATIONS

None to date (requires flight data).

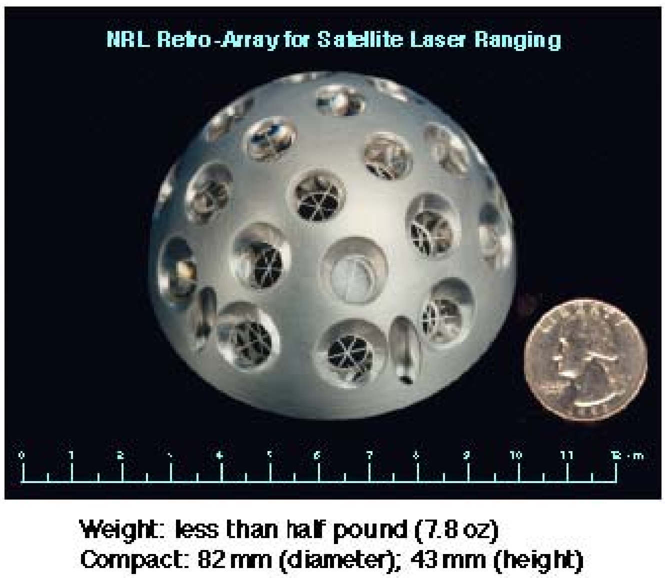

Figure 1. NEMO Retroreflector Array.